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Tasja Buschhardt[a*], Martin Iain Bahl[a], Tina Beck Hansen[a], Asker Daniel Brejnrod[b], Waleed Abu Al-Soud[b], Martin Steen Mortensen[b], Søren Johannes Sørensen[b], and Søren Aabo[a]

[a]Technical University of Denmark – National Food Institute, Kemitorvet Building 204, DK2800 Kgs. Lyngby, Denmark , [b]University of Copenhagen – Department of Biology, Section of Microbiology, Universitetsparken 15, DK-2100 København Ø

Violations of temperature regulations in the meat chain may affect meat safety. Methods are lacking to estimate whether meat has been subjected to temperature abuse. Exposure to too high temperatures may lead to systematic changes in the diverse bacterial communities of fresh meat. We investigated whether temperature induced changes in the community composition on fresh meat surfaces can reflect the temperature-history (combination of time and temperature). Sterile pieces of pork were inoculated with a carcass swab homogenate, to which *Salmonella* was added. Changes in the meat microbiota were monitored during aerobic chill-storage (4 °C and 7 °C) and temperature abuse (12 °C and 16 °C) for 96 hours, by culture-based methods and 16S rRNA gene sequencing. Bacterial genera that dominated during prolonged temperature abuse were *Acinetobacter*, *Serratia* and *Pseudomonas,* whereas chill-stored meat was dominated by *Pseudomonas* only. We also showed that the initial community affects subsequent changes during storage. The results suggest that principal coordinate analysis of beta diversity could be a useful tool to reveal temperature abused meat. Sequence data and culturing data revealed a strong positive association between growth of *Escherichia coli* and growth of *Salmonella*, which suggests that *Escherichia coli* can be used as indicator of temperature-history supporting growth of *Salmonella* on fresh pork surfaces.